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## Overview

This standard covers the competence and knowledge technicians need to safely carry out the removal and replacement of components in hydrogen fuel cell electric vehicle (FCEV) systems. The unit also ensures that the technician is aware of the hazards posed by hydrogen fuel cell electric vehicle systems and the safe working practices to follow when carrying out removal and replacement activities.

**Warning: It has been recommended by industry experts that only those with suitable training and experience on working with electric vehicles should carry out the functions below.**

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## Performance criteria

### You must be able to:

P1 Identify that the vehicle has a hydrogen fuel cell electric vehicle system and collect relevant technical information

P2 Wear personal protective equipment (PPE) and use vehicle protection **equipment** (VPE) appropriate to the work activities you are carrying out

P3 Ensure the vehicle is safe to work on

P4 Ensure the work area is clearly identified using signs and barriers as appropriate, following environmental standards and regulations all times

P5 Support your work activities by reviewing:

P5.1 system manufacturer's vehicle technical data

P5.2 removal and replacement procedures

P5.3 legal requirements

P6 Prepare, check and use all the appropriate **equipment** required following manufacturer's instructions

P7 Work in a way which minimises the risk of:

P7.1 damage to other vehicle systems, **components** and units

P7.2 damage to your working environment

P7.3 injury to yourself and others

P8 Select replacement **components** which meet the manufacturer's recommendations or conform to operating specification

P9 Carry out **component** removal and replacement activities following:

P9.1 manufacturers' instructions

P9.2 industry recognised repair methods

P9.3 health, safety and environmental requirements

P10 Record and report any relevant/related faults you notice during the course of your work

P11 Follow manufacturer's instructions to test and evaluate the performance of the reassembled hydrogen fuel cell electric vehicle system accurately and ensure other associated systems operate correctly

P12 Ensure your records are accurate, complete and passed to the relevant person(s) promptly in the format required

## Knowledge and understanding

### You need to know and understand:

#### Use of technical information

K1 The different types of hydrogen fuel cell electric vehicle systems and associated hydrogen storage systems

K2 How to find, interpret and use sources of information applicable to component removal and replacement within a hydrogen fuel cell electric vehicle system

K3 The importance of using the correct sources of technical information for hydrogen fuel cell electric vehicle **component** construction

#### Legislative and organisational requirements and procedures \*

**K4 The health and safety legislation, industry codes of practice or guidelines and workplace procedures relevant to working with hydrogen fuel cell electric vehicles**

**K5 How to select, check and use appropriate personal protective \*equipment** and vehicle protective **equipment** when working on hydrogen fuel cell electric vehicles

K6 How to ensure the environment is safe when working on a hydrogen fuel cell electric vehicle

K7 How to immobilise, store and mobilise a hydrogen fuel cell electric vehicle and its **components** safely in accordance with manufacturer's recommendations

K8 Your workplace procedures for the:

K8.1 referral/reporting of problems when working with hydrogen fuel cell electric vehicles

K8.2 how to make others aware that work is being carried out on a hydrogen fuel cell electric vehicle

K9 The precautions necessary when using hydrogen re-fuelling **equipment**

K10 How to carry out a risk assessment on damaged and broken-down hydrogen fuel cell electric vehicles

K11 How to confirm a hydrogen fuel cell electric vehicle is safe to work on

K12 Hazards associated with hydrogen and hydrogen under high-pressure, including the physiological, mechanical and chemical effects of hydrogen

K13 The hazards associated with hydrogen fuel cell electric vehicles when exposed to extreme temperatures, impact and other adverse conditions

K14 The implications of electrical conductivity through the human body and the potential medical conditions that can occur regardless of voltage or current type present in a hydrogen fuel cell electric vehicle

K15 How to dispose of, recycle and return any removed hydrogen fuel cell electric vehicle system **components** in line with legislative, environmental and organisational requirements

K16 How to work safely avoiding damage to other vehicle systems, **components** and units and contact with leakage and hazardous substances

#### Hydrogen fuel cell and the vehicle system principles

K17 The basic construction of a hydrogen polymer electrolyte/proton-exchange

membrane (PEM) fuel cell

K18 The electrochemical reactions in a PEM fuel cell

K19 The purpose of the membrane in a PEM fuel cell

K20 How a PEM fuel cell operates

K21 The by-products of the PEM fuel cell chemical reaction

K22 The differences between PEM fuel cell and other alternative fuel cell technologies which may come into general use

K23 The reasons for connecting PEM fuel cells into a stack

K24 On-board hydrogen fuel storage and supply systems

K25 The types of hydrogen production

### **Vehicle equipment faults and their correction**

K26 How to identify faults and damage in hydrogen fuel cell electric vehicle systems and **components**

K27 How to remove, replace, test and evaluate the performance of **components** and the reassembled system against operating specifications and legal requirements

K28 The importance of ensuring **components** are functioning correctly before release to the customer

### **Hydrogen fuel cell electric vehicle systems and components**

K29 How hydrogen supply system **components** function and are constructed

K30 How to identify the location of hydrogen and high-pressure hydrogen pipes and other system **components**, for example, by labelling or colour

K31 The different pressures and voltages associated with **components** in hydrogen fuel cell electric vehicles

K32 How hydrogen fuel cell electric vehicle systems interact with other vehicle systems

K33 The manufacturers's specification for the type and quality of **components** to be used for replacement

K34 The different types of energy storage systems and voltages associated with hydrogen fuel cell electric vehicles

K35 The ancillary **components** of alternative fuel sources and systems on hydrogen fuel cells

### **Use of tools and testing equipment and testing techniques**

K36 How to select and use the testing **equipment** required

K37 How to select, prepare, check and use all the repair and replacement **equipment** required

K38 How to conduct tests on hydrogen fuel cell electric vehicle systems following safety and workplace procedures

K39 How to conduct a test on energy sources and systems

K40 How to determine the serviceability of a **component** in a hydrogen fuel cell electric vehicle system

K41 How to interpret the results of your tests and make recommendations based on these results

K42 The importance of basing your recommendations on test results

### **Vehicle system operation**

K43 The main differences between a hydrogen fuel cell electric vehicle (FCEV) and a battery electric vehicle (BEV) and its operation

K44 How to safely operate a hydrogen fuel cell electric vehicle

K45 The specific manufacturer's guidelines and the precautions necessary when

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charging, connecting an auxiliary power source to or towing/lifting an electric vehicle  
K46 The evacuation and re-fuelling systems associated with hydrogen fuel cell electric vehicles and how to operate them safely

## Scope/range

### **1. Equipment** includes:

- 1.1. hand tools
- 1.2. code readers
- 1.3. special tools, for example manufacturer specific equipment and software
- 1.4. safe and appropriate electrical testing equipment
- 1.5. relevant safety equipment
- 1.6. hydrogen leak detector
- 1.7. hydrogen evacuation equipment

### **2. Testing methods** include:

- 2.1. sensory
- 2.2. functional
- 2.3. measurement

### **3. Components** include:

- 3.1. re-fuelling components
- 3.2. supply pipes
- 3.3. safety venting systems
- 3.4. valves and safety devices
- 3.5. storage tanks
- 3.6. insulation and protection methods and components
- 3.7. fuel cell stack
- 3.8. fuel cell components
- 3.9. electronic control units, sensors and actuators
- 3.10. driver inputs and instrumentation
- 3.11. pressure reduction devices
- 3.12. service items

## Glossary

*This section contains examples and explanations of some of the terms used but does not form part of the standard.*

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### **Fuel cell system**

Includes fuel cell and fuel cell stack, hydrogen storage and supply, on-board fuelling systems and safety and control systems

**Hazards associated with high voltage electrical vehicle components** - exist not only during work on high voltage systems, as specified above, but also on all other high-power electrical drive systems and high-pressure storage systems. Vehicle and equipment manufacturers' guidance should be followed at all times.

### **Hazards associated with hydrogen and hydrogen fuel cell electric vehicle systems \***

***Physiological (e.g. frostbite, respiratory ailments, injury from unexpected release of pressure and asphyxiation), mechanical (for example, embrittlement) and chemical (flammable - burns without visible flame, causes explosive atmospheres).***

**\*High voltage** – Regulation No 100 of the Economic Commission for Europe of the United Nations (UNECE) — Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train, states that: 'High Voltage' means the classification of an electric component or circuit, if its working voltage is > 60 V and ≤ 1 500 V DC or > 30 V and ≤ 1 000 V AC root mean square (rms). Electricity at Work Regulations (1989), and associated HSE guidance should be followed at all times.

### **Sensory testing methods**

Include looking, listening, smelling, touching for temperature or vibration.

### **Sources of information applicable to electric vehicles**

Examples include hard copy manuals, data on computer and data obtained from on-board diagnostic displays.

**\*Vehicle \***

Fuel Cell Electric Vehicle (FCEV)

IMIEV07L

Remove and replace components in a hydrogen fuel cell electric vehicle system Legacy



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Version Number	1
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Validity	Legacy
Status	Original
Originating Organisation	IMI Ltd
Original URN	IMIEV07
Relevant Occupations	Light Vehicle Diagnostic Technician (Automotive), Light Vehicle Master Technician (Automotive), Light Vehicle Service Technician (Automotive), Bus and Coach Mechanic, Bus and Coach Electrician, Bus and Coach Mechelec, Bus and Coach Master Technician
Suite	Electric and Hybrid Vehicles, Maintenance and Repair - Light Vehicle, Maintenance and Repair - Heavy Goods and Public Service Vehicles
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